REMARKS

This paper responds to the Office Action mailed on August 23, 2005.

Claims 1, 9, 14, 22, 30, 51 and 55 are amended, no claims are canceled, and claim 62 is added; as a result, claims 1, 2, 5-10, 13-15, 18-23, 26-31, 34–37, 51, 52, 54-56, and 62 are now pending in this application.

Information Disclosure Statement

Applicant submitted a Supplemental Information Disclosure Statement and 1449 Form on June 7, 2005, and submits another Supplemental Information Disclosure Statement herewith. Applicant respectfully requests that initialed copies of the 1449 Forms be returned to Applicants' Representatives to indicate that the cited references have been considered by the Examiner.

§103 Rejection of the Claims

Claims 1-2, 3, 6, 14-15, 17, 19, 51-52, and 55-56 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma (U.S. 6,207,589) in view of Park (U.S. 5,795,808). Applicant respectfully traverses this rejection.

The cited Ma reference discloses a transistor having a metal oxide gate dielectric formed of either Zr or Hf alloyed with approximately 25% of a trivalent metal such as aluminum, or lanthanum. The metal oxide is formed by either sputtering in an oxygen ambient, cosputtering in an oxygen ambient, chemical vapor deposition in an oxygen ambient, or evaporation and annealing in an oxygen ambient. The final structure has an interface barrier 62 having a thickness 64 of typically 2-5 angstroms. The interface barrier 62 is formed of either silicon nitride or silicon oxynitride (see col. 2, line 17 and col. 6, line 9 and figures 12 and 13).

The cited Park reference is used in the outstanding Office Action to show that sputtering and evaporation are art recognized equivalents.

Applicant respectfully disagrees with the Examiner's statement on page 13, first paragraph that Ma teaches a pure metal. The cited section (col. 5, line 66) of the Ma reference states that the "percentage of Al, or other trivalent metal, in film 56 is in the range of approximately 0-50%. Preferably, the percentage of Al in film 56 is approximately 25%".

Applicant does not understand how the Examiner can state that a reference that specifically teaches the use of a large percentage trivalent metal content in the metal to be oxidized, specifically for the purpose of reducing the leakage current (col. 3, line 45), would lead one of ordinary skill in the art to use a pure metal. The cited reference of Ma is seen as teaching throughout the specification the use of heavy trivalent metal doping for the gate oxide. Applicant respectfully submits that one of ordinary skill in the art could not read the Ma reference and deduce that the use of a "... *substantially single element metal layer directly contacting the body region* ...", as recited in claim 1. No one could read Ma and believe that the reference was teaching the use of pure metals.

Applicant further submits that Ma does not teach that sputtering and evaporation are equivalent operations. The present specification, as noted in figure 2b and 2c, and discussed at least at page 3, line 10 to line 24, discloses that sputtering causes physical and radiation damage to the substrate surface that cannot be repaired by annealing, resulting in rough surfaces. Devices that need low leakage currents cannot use sputtering for depositions on sensitive surfaces such as the bare channel regions of a MOSFET, and the use of sputtering would result in an inoperative device. Applicant cannot find the question of smoothness of the initial semiconductor surface or the smoothness of the oxidized metal layer with respect to the leakage current problem in the cited reference. The smoothness is only noted to increase the electron mobility (col. 6, line 11). Thus, since the cited reference of Ma does not understand that the sputtering of metal causes rough surfaces that can not be corrected and resulting in increased leakage currents, then the Ma reference is an inappropriate reference.

Applicant respectfully disagrees with the Examiner's statement on page 13, second paragraph, that Ma discloses the metal layer being directly deposited on the channel region. The cited section is a rough flow chart that starts out with "Step 100 provides an integrated circuit (IC) having a surface" which surface would have the barrier layer previously described as interface barrier 62, formed of either silicon nitride or silicon oxynitride (col. 2, line 17; col. 6, line 9; figures 12 and 13) and also referred to at column 6, line 67. The cited section of Ma does not argue against the use of the interface barrier, as suggested by the Examiner, but rather takes the presence of the barrier as a given. Thus the cited references do not suggest "... *a metal oxide layer directly contacting the body region* ...", as recited in independent claim 1.

Applicant respectfully submits that the cited references, whether taken alone or in any combination, neither describe nor suggest at least the combination of claimed features of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; and oxidizing the metal layer to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer has a smooth surface with a surface roughness variation of 0.6 nm ...*", as recited in independent claims 1 and 14, as amended herein. In addition to the failures noted immediately above, the suggested combination does not disclose the surface roughness.

The dependent claims are believed patentable at least as depending from patentable base claims, as discussed above. In view of the above argument, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 5, 7, 18, and 20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Yano (U.S. 5,810,923). Applicant respectfully traverses this rejection.

Ma and Park have features that have been discussed above. Yano is apparently used in the outstanding Office Action to show that the deposition temperature range and the use of atomic oxygen are known.

Applicant submits that there is nothing in the cited reference of Yano that cures the above noted deficiencies in the combination of Ma and Park with regard to independent claims 1 and 14, from which the claims in question depend. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 8, 21, and 54 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Moise (U.S. 6,211,035). Applicant respectfully traverses this rejection.

Ma and Park have features that have been discussed above. Moise is used in the outstanding Office Action to show that oxidizing in a krypton and oxygen mixed plasma is known.

Applicant respectfully submits that the addition of the Moise reference to the suggested combination of Ma and Park does nothing to cure the above-noted deficiencies in the combination of Ma and Park with regard to independent claims 1, 14 and 51. In particular, the suggested combination does not suggest the surface roughness, the direct contact to the channel region, the use of a pure metal, or the substantial amorphousness of the deposited metal.

Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 9-10 and 12 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Moise. Applicant respectfully traverses this rejection.

The references have all been discussed above, and it is submitted that the suggested combination fails to describe or suggest "...*evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; and oxidizing the metal layer using a krypton(Kr)/oxygen (O_2) mixed plasma process to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer has a smooth surface with a surface roughness variation of 0.6 nm* ...", as recited in claim 9, as amended herein. This is true for many of the same reasons given above with reference to the prior rejections, and further because of the oxidation of the metal using a mixed Kr/O plasma. Ma discloses an interface barrier, the use of sputtering, no consideration of the surface smoothness, and the addition of the Park and Moise references are not seen as providing any teaching to cure the deficiencies of Ma. Therefore, independent claim 9 is believed patentable over the suggested combination of references.

The dependent claims are believed patentable at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claim 13 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park and Moise, and further in view of Yano. Applicant respectfully traverses this rejection.

The references of Ma, Park and Moise have all been discussed above. The cited reference of Yano is used in the outstanding Office Action to show that zirconium may be deposited at 300

to 700 °C. The cited reference of Yano is not seen as providing a cure for the deficiencies of the combination of Ma, Park and Moise as discussed above with reference to claim 9, from which claim 13 depends.

Applicant respectfully submits that the suggested combination fails to describe or suggest "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; and oxidizing the metal layer using a krypton(Kr)/oxygen (O_2) mixed plasma process to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer has a smooth surface with a surface roughness variation of 0.6 nm ...*", as recited in claim 9, as amended herein. The reasons are similar to those given above with reference to t he prior rejection. Dependent claim 13 is believed patentable at least as depending from claim 9 shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 22-23, 25, 27, 30-31, 33, and 35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Maiti (U.S. 6,020,024) and the admitted prior art. Applicant respectfully traverses this rejection.

Ma and Park have been discussed above. The cited Maiti reference discloses a high dielectric constant metal oxide layer on a silicon nitride layer grown on the body region of a semiconductor device. The silicon nitride layer 14 is intentionally formed by Maiti by ion implantation of nitrogen, thermal nitridation of an oxide layer by ammonia, nitric oxide, nitrous oxide, or plasma/thermal processing, and is an essential feature of Maiti (see col. 3, lines 24-26). Maiti is used in the outstanding Office Action to show that it is known to use high k metal oxides for transistors. The "AAPA" is used to show that processor chips are known.

The suggested combination fails to describe or suggest at least the claimed feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; oxidizing the metal layer to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer has a smooth surface with a surface roughness variation of 0.6 nm...*", as recited in claims 22 and 30.

As discussed previously the suggested combination of references does not suggest direct deposition of a metal on the channel region, the surface roughness, or the oxidation of the metal.

The dependent claims are held to be in patentable condition at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 26, 28, 34, and 36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view of Maiti and the admitted prior art, and further in view of Yano. Applicant respectfully traverses this rejection.

The cited Ma, Park, Maiti and AAPA references have been discussed above. Yano is used to show that zirconium deposited at 300-700 °C is known.

Applicant respectfully submits that Yano does not cure the above noted deficiencies of the combination of Ma. Park, Maiti and "AAPA" with respect to base claims 22 and 30 as discussed above. Specifically, Yano does not help with the failure of the suggested combination to describe or suggest at least the claimed feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; oxidizing the metal layer to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer has a smooth surface with a surface roughness variation of 0.6 nm...*", as recited in claims 22 and 30.

The dependent claims are held to be in patentable condition at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 29 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma in view of Park, and further in view Maiti and the admitted prior art, and further in view of Moise. Applicant respectfully traverses this rejection.

The cited references have all been discussed above. Applicant respectfully submits that independent claims 22 and 30, from which claims 29 and 37 respectively depend, are patentable over at least because the suggested combination of references fails to describe or suggest at least

the claimed feature of "*...evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; oxidizing the metal layer to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer has a smooth surface with a surface roughness variation of 0.6 nm...*", as recited in claims 22 and 30, as amended herein.

Applicant respectfully disagrees with the statement in the outstanding Office Action on page 12, second paragraph that "Moise teaches oxidizing a metal layer with inert gases such as argon or krypton (column 12 lines 23-24)", since it is not possible to oxidize in an inert ambient. Further, the cited section of Moise is discussing a plasma etch of a dielectric layer, and who suggest nothing to one of ordinary skill in the art with regard to oxidizing a metal layer.

The dependent claims are held to be in patentable condition at least as depending from claims shown above to be patentable. Applicant respectfully requests that this rejection be reconsidered and withdrawn.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney David Suhl at 508-865-8211, or the below-signed attorney at (612) 373-6900, to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

KIE Y. AHN ET AL.

By their Representatives,

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Date 24 Oct '05 (Monday)

By _____
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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Mail Stop RCE, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 24 day of October, 2005.

KACIA LEE

Name

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Signature